Making useful chemicals – 2021/20 GCSE 21st Chemistry B

1. Nov/2021/Paper_J258/01/No.8(b)

(b) James has a solution of chlorine in water.

He tests the solution with **blue** litmus paper.

State **two** colour changes that James will see.

1 .....

2 .....

[2]

2. Nov/2021/Paper_J258/01/No.9

Alex reacts zinc with excess hydrochloric acid.

Fig. 9.1 shows the apparatus Alex uses:

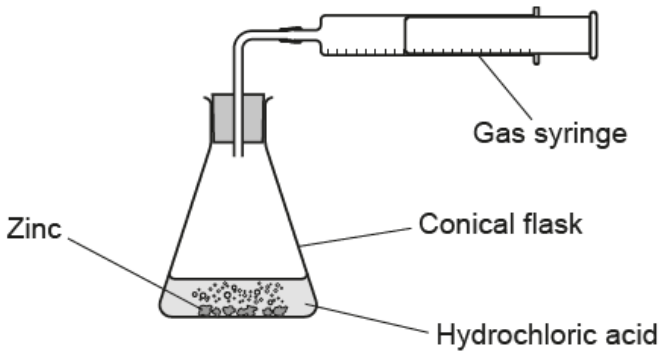


Fig. 9.1

(a) Alex measures the volume of gas made at the start and then again after every minute for 7 minutes.

Fig. 9.2 shows a graph of his results:

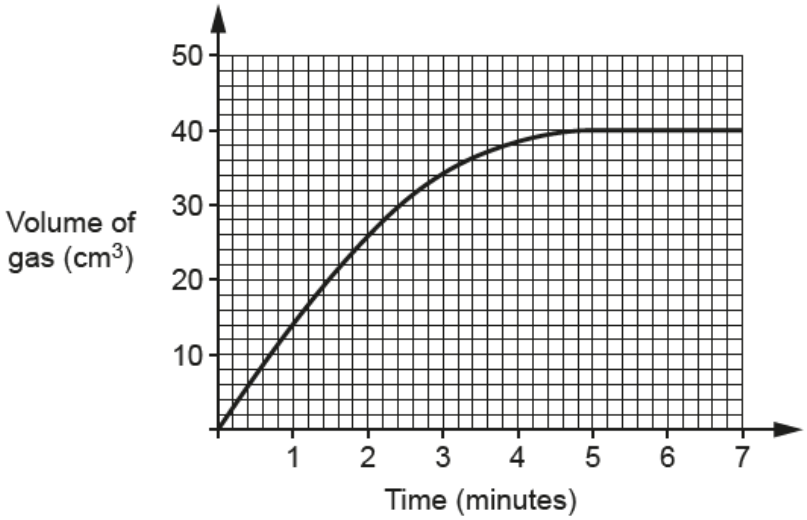


Fig. 9.2

(i) What is the gradient of the curve at 5 minutes?

Gradient = ... cm^3/minute **[1]**

(ii) What happens to the reaction after 5 minutes?

.....

..... **[1]**

(b) Which value is a correct estimate for the rate at which the reaction starts?

Use **Fig. 9.2**.

Tick (✓) **one** box.

0.08 cm^3 / minute	☐
0.1 cm^3 / minute	☐
10 cm^3 / minute	☐
14 cm^3 / minute	☐
40 cm^3 / minute	☐

[1]

(c) 2.0 g of zinc makes a total of 800 cm^3 of gas.

Calculate the mass of zinc Alex used in his experiment.

Use the total volume of gas produced in **Fig. 9.2**.

Mass of zinc = ... g **[2]**

(d) Alex repeats the experiment with different metals and excess acid.
He wants to compare the rate of reaction for the different metals.

State **two** factors that he should control in these experiments to get valid results.

1 .....

2 .....

[2]

(e) **Fig. 9.3** shows Alex's results for **zinc**, **magnesium** and **iron**:

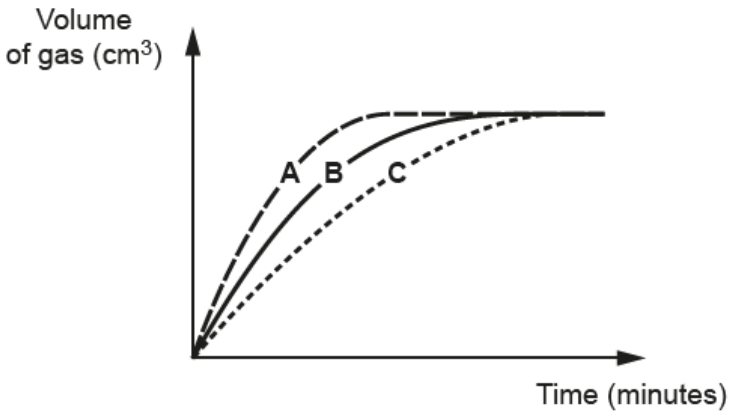


Fig. 9.3

Which metal makes each curve in **Fig. 9.3**?

Curve **A** .....

Curve **B** .....

Curve **C** .....

[2]

3. Nov/2021/Paper_J258/02/No.6

Table 6.1 shows the concentration and the pH of some dilute acids.

Name of acid	Concentration of dilute acid (mol/dm^3)		pH
Hydrochloric acid	Concentration gets lower ↓	0.1	1.0
		0.01	2.0
		0.001	3.0
Sulfuric acid	Concentration gets lower ↓	0.1	0.7
		0.01	1.7

Table 6.1

(a) All of the acids in the table react with magnesium metal.

Which acid gives the **fastest** reaction?

Tick (✓) **one** box.

$0.1\ mol/dm^3$ hydrochloric acid ☐

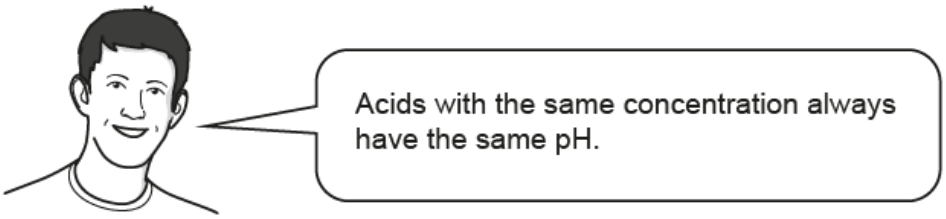
$0.01\ mol/dm^3$ hydrochloric acid ☐

$0.1\ mol/dm^3$ sulfuric acid ☐

$0.01\ mol/dm^3$ sulfuric acid ☐

[1]

(b) Alex has an idea about pH.



Does the data in **Table 6.1** agree with Alex's idea?

Yes ☐

No ☐

Use data from **Table 6.1** to explain your answer.

.....

.....

.....

..... **[2]**

(c) Alex tests the pH of some samples of dilute nitric acid. He uses Universal Indicator and a pH meter.

Table 6.2 shows his results.

Concentration of dilute nitric acid (mol/dm^3)		pH using Universal Indicator	pH using pH meter
Concentration gets lower ↓	0.1	1	1.0
	0.05	1	1.3
	0.01	2	3.5
	0.001	3	3.0

Table 6.2

(i) Describe how Alex uses Universal Indicator to measure the pH of the acids.

.....

.....

.....

..... **[2]**

(ii) Alex says that the results in **Table 6.2** contain an outlier.

Put a (ring) around the result that is an outlier in **Table 6.2**. **[1]**

(iii) Explain your answer to **(c)(ii)**.

.....

.....

.....

.....

[2]

(iv) Alex says that using a pH meter rather than Universal Indicator to measure pH improves the quality of the data.

Suggest **one** reason why this is true.

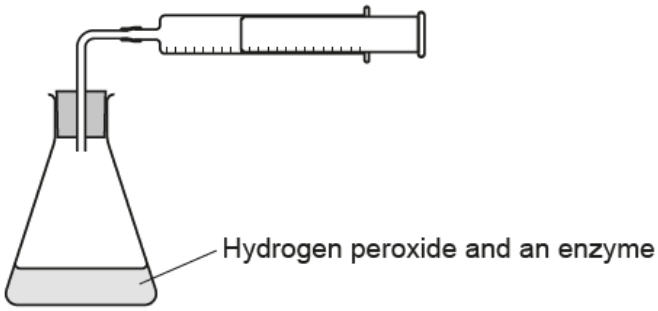
.....

..... **[1]**

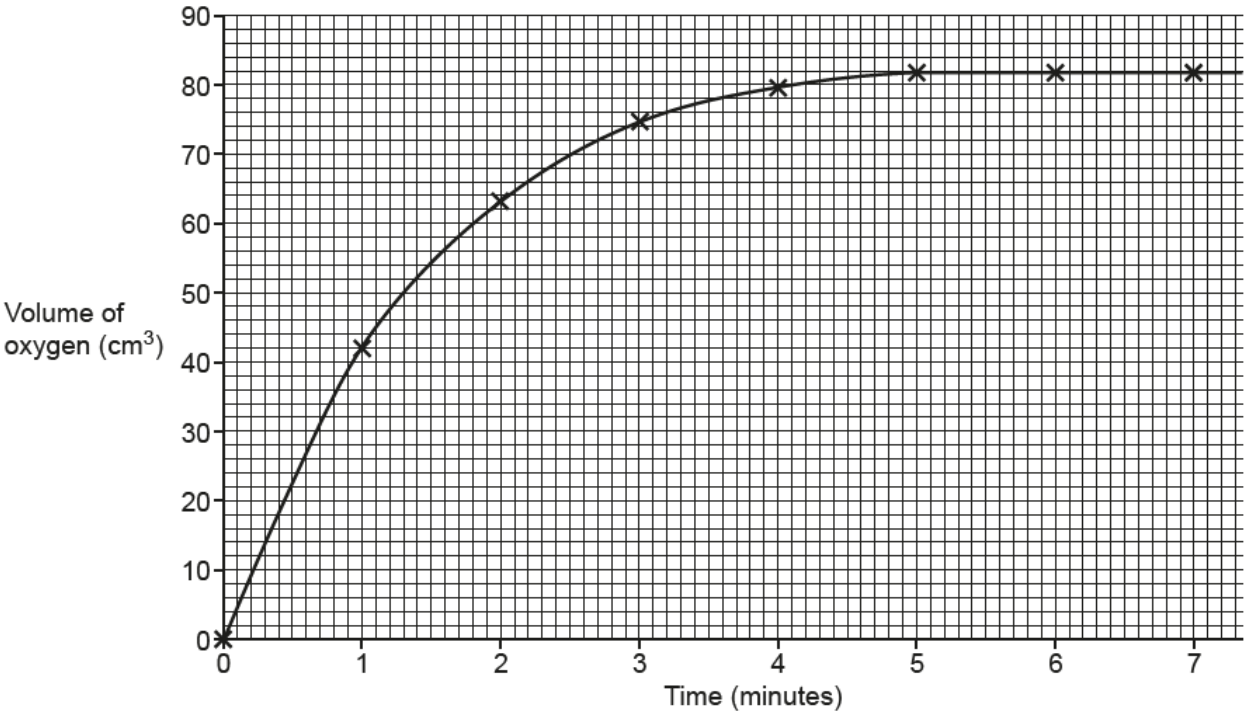
4. Nov/2021/Paper_J258/02/No.9

Hydrogen peroxide is a waste product produced by cells in our bodies. Hydrogen peroxide is broken down by an enzyme to form water and oxygen.

Beth adds a small amount of an enzyme to some hydrogen peroxide. She collects the oxygen given off in a gas syringe. She records the total volume of oxygen every minute.



The graph shows her results.



(a) Use the graph to help you answer **(a)**.

(i) How long does it take for the reaction to finish?

..... minutes **[1]**

(ii) How much oxygen is given off by the end of the reaction?

..... cm^3 **[1]**

(iii) Calculate the average volume of oxygen given off **per second**.

..... cm^3/s **[2]**

(b) The reaction that breaks down hydrogen peroxide does not start until the enzyme is added. When the enzyme is added, oxygen is given off quickly.

Explain this statement.

Use ideas about rates of reaction in your answer.

.....

.....

.....

..... **[2]**

5. Nov/2020/Paper_J258/01/No.9

Ammonia is used to make synthetic fertilisers.

(a) Ammonia is manufactured in the Haber process.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

Which statements about this reaction are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
2 moles of nitrogen react with 3 moles of hydrogen.		
The reaction reaches a 100% yield.		
At equilibrium, the forward reaction is faster than the backward reaction.		

[3]

(b) Sundip makes ammonium sulfate from a solution of ammonia in the laboratory. The method is shown below but is **not** in the correct order.

Write a number from **1–6** in each box to give the correct order for the steps of the method.

Step	Method
	Wait for the crystals to form after the solution has cooled down.
	Slowly evaporate the solution until most of the solution has gone.
	Wash and dry the crystals.
	Put some sulfuric acid in a beaker.
	Add ammonia until the solution is alkaline.
	Filter the solution.

[2]

(c) Sundip makes 9.9 g of ammonium sulfate.

The maximum mass of ammonium sulfate she could have made is 13.2 g.

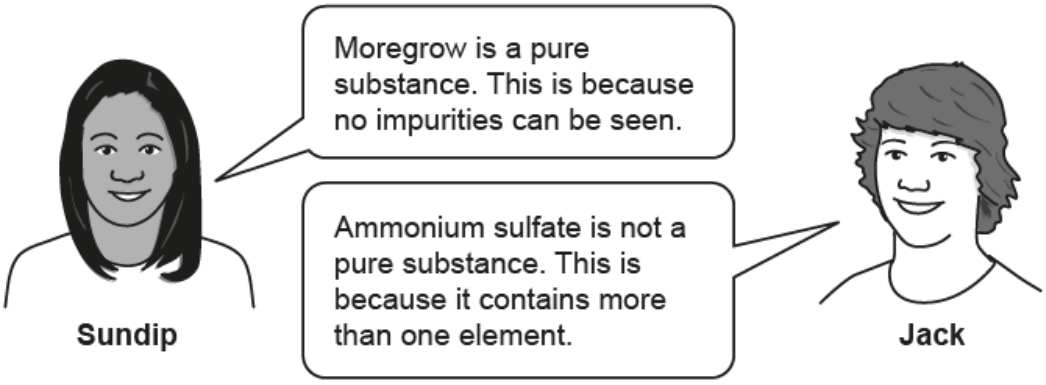
Calculate the percentage yield.

Use the formula: percentage yield = $\frac{\text{mass made}}{\text{maximum mass}} \times 100\%$

Percentage yield = ... % **[2]**

(d) Ammonium sulfate is mixed with other compounds to make the fertiliser Moregrow. Moregrow is a white powder.

Sundip and **Jack** talk about the compounds in Moregrow:



Do you agree with each person's comments?

Give **one** reason for each of your answers.

Sundip .....

.....

.....

Jack .....

.....

.....

[2]

6. Nov/2020/Paper_J258/01/No.11

Beth has some tablets that react by fizzing, and then dissolving, when water is added.

Beth puts a whole tablet into **Tube A**, and a broken-up tablet into **Tube B**.

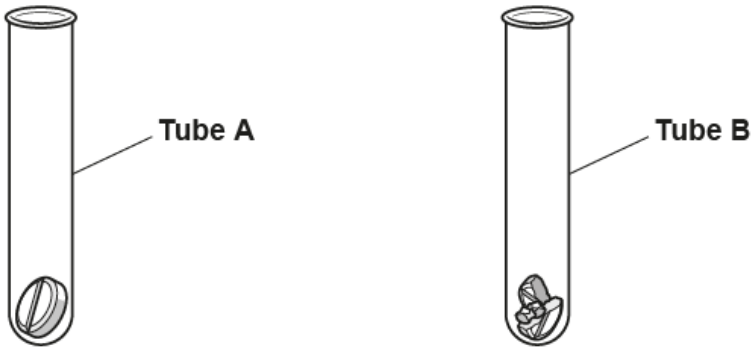


Fig. 11.1

(a) Beth wants to measure the rate of the two reactions. This is Beth's method:

- Add the same volume of **cold** water to each test tube at the same time.
- Start a stopwatch.

(i) When should Beth stop the stopwatch?

Tick (✓) **one** box.

When the bubbles start to appear. ☐

When the fizzing starts. ☐

When the fizzing stops. ☐

When only a small amount of tablet is left. ☐

[1]

(ii) Which type of tablet, whole or broken-up, will dissolve more quickly?

Whole tablet ☐

Broken-up tablet ☐

Explain your answer.

Use ideas from the particle model in your answer.

.....

.....

..... **[2]**

(b) Suggest **one** reason why the reactions are much faster using **hot** water.

.....

..... **[1]**

(c) **Fig. 11.2** shows how the mass of **Tube A** and its contents changes over time when cold water is added.

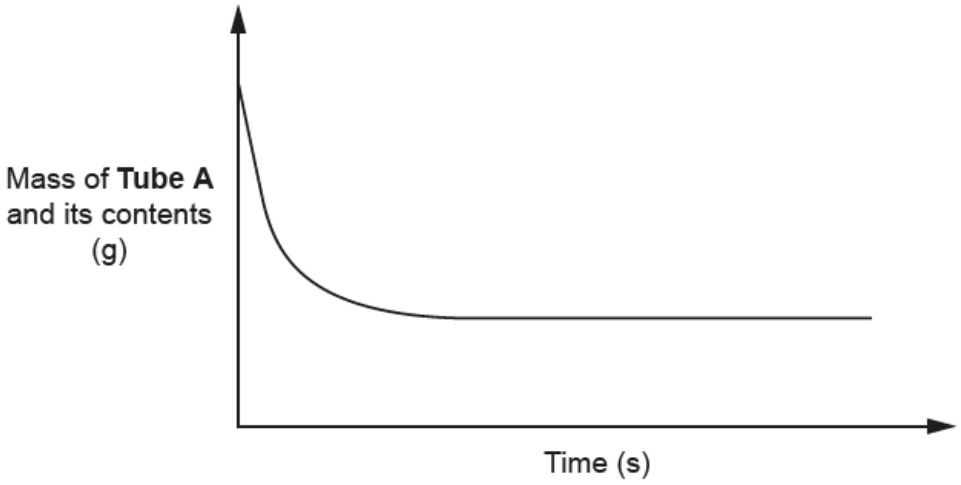


Fig. 11.2

(i) Using **Fig. 11.2**, explain why the mass of **Tube A** and its contents decreases during the reaction.

.....

..... **[1]**

(ii) The rate of the reaction decreases with time.

Describe how **Fig. 11.2** shows this.

.....

..... **[1]**

(iii) Explain why the rate of reaction decreases with time.

.....

..... **[1]**

7. Nov/2020/Paper_J258/02/No.2

Nina works for a company that makes pH meters.

She makes up four solutions **A**, **B**, **C** and **D**. Each solution has a different, known pH.

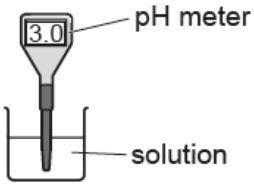
Table 2.1 shows the pH of each solution.

Solution	pH
A	3.0
B	9.0
C	1.0
D	7.0

Table 2.1

(a) Nina tests three pH meters to find out if they measure pH accurately.

She uses the three pH meters to measure the pH of solutions **A**, **B**, **C** and **D**. She dips each pH meter into each solution and takes a reading.



(i) Nina washes each pH meter between readings.

Explain why it is important that she does this.

.....

..... **[1]**

(ii) **Table 2.2** shows Nina's results.

Solution	actual pH	pH meter 1 reading	pH meter 2 reading	pH meter 3 reading
A	3.0	3.1	3.0	3.3
B	9.0	9.1	9.0	9.1
C	1.0	0.9	1.0	1.1
D	7.0	6.8	7.0	6.7

Table 2.2

Nina decides that the pH meter gives accurate readings if all of its pH readings are within **+/−0.2** of the actual pH.

Tick (✓) **one** box in each column to show whether each pH meter gives **accurate** or **inaccurate** readings.

	pH meter 1 (✓)	pH meter 2 (✓)	pH meter 3 (✓)
Accurate			
Inaccurate			

[2]

(b) **(i)** Nina wants to use another method to measure pH.

What other method could she use to measure pH?

Tick (✓) **one** box.

Do a titration. ☐

Test with litmus paper. ☐

Test any gases given off with lime water. ☐

Use Universal Indicator. ☐

[1]

(ii) Explain why scientists often use more than one method to collect results when they do experiments.

.....

.....

.....

..... **[2]**

8. Nov/2020/Paper_J258/04/No.4

Beth does an experiment to measure the rate of reaction between zinc and dilute hydrochloric acid.

(a) Complete the word and balanced symbol equation for the reaction.

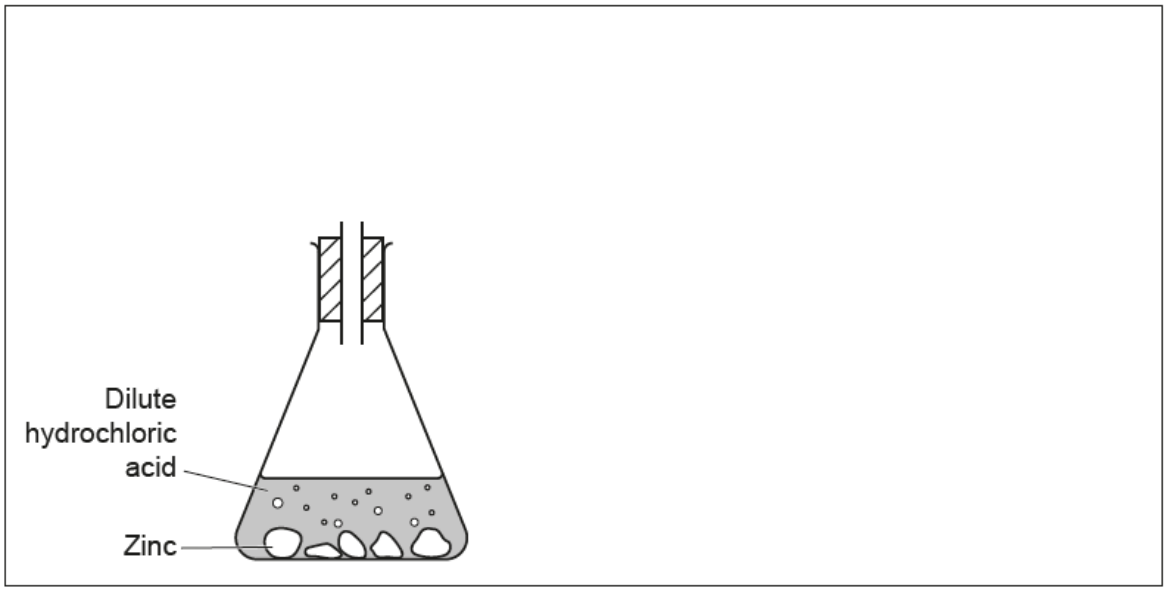
zinc + hydrochloric acid → hydrogen + ...

Zn + ...HCl → ..... + $ZnCl_2$

[2]

(b) Complete the diagram to suggest how the hydrogen gas could be collected and measured.

Include labels on your diagram.



[2]

(c) Beth repeats her experiment with different concentrations of dilute hydrochloric acid. She uses the same volume of acid each time.

She measures the volume of gas collected in 20 s for each experiment.

Fig. 4.1 shows her **five** results.

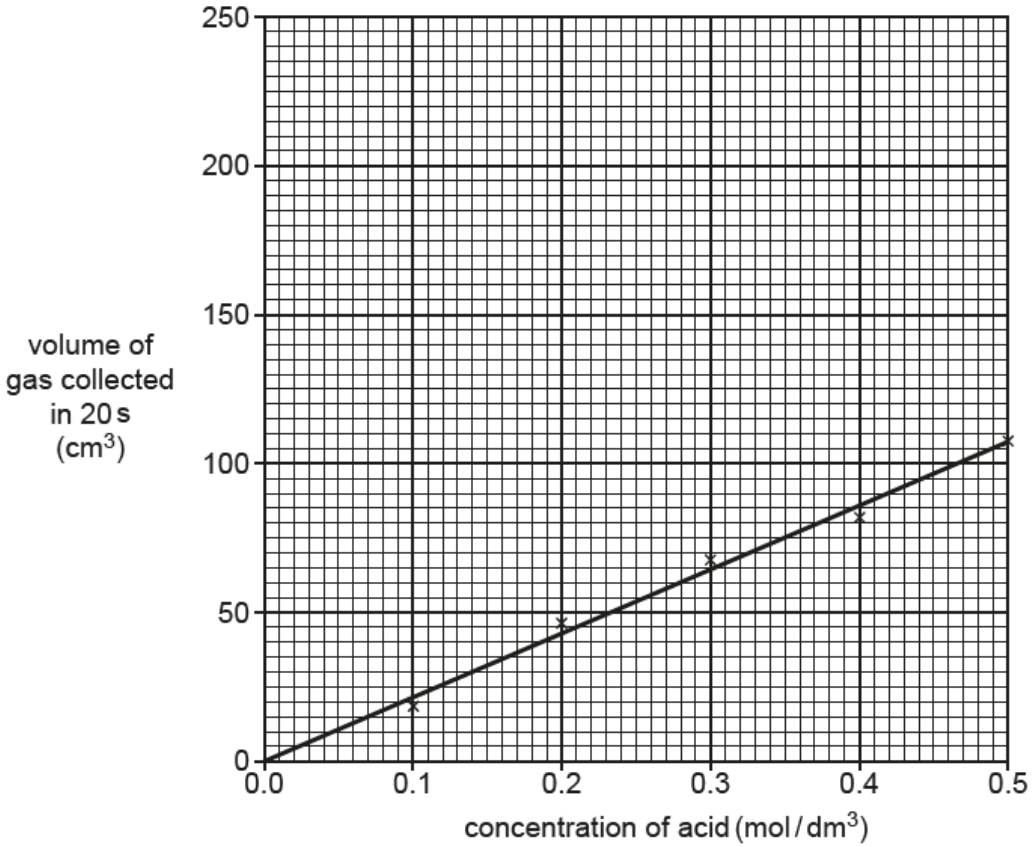


Fig. 4.1

(i) Calculate the gradient of the line.

Show your working on the graph.

Gradient = ... $cm^3/mol/dm^3$ **[2]**

(ii) Estimate the concentration of dilute hydrochloric acid needed to produce 250 cm^3 of gas in 20 s.

Use the equation: volume of gas produced in 20 s = gradient × concentration of acid

Concentration = ... mol/dm^3 **[2]**

(d) Beth repeats her experiment again but this time measures the rate of reaction between zinc and dilute sulfuric acid, H_2SO_4, rather than dilute hydrochloric acid, HC*l*.

Table 4.1 shows her results.

Concentration of dilute sulfuric acid H_2SO_4 (mol / dm^3)	**Volume of gas produced in 20 s (cm^3)**
0.1	40
0.2	85
0.3	125
0.4	170
0.5	215

Table 4.1

(i) Plot the results in **Table 4.1** on **Fig. 4.1**.

Draw a line of best fit. **[2]**

(ii) Explain why the two lines on **Fig. 4.1** have different gradients.

.....

.....

.....

..... **[2]**

9. Nov/2021/Paper_J258/03/No.2

Water evaporates from lakes and oceans. It forms clouds of gaseous water.

In the right conditions the water falls as rain, as shown by the equation:

$H_2O(g) \longrightarrow H_2O(l)$

(a) Which **two** processes does this equation show?

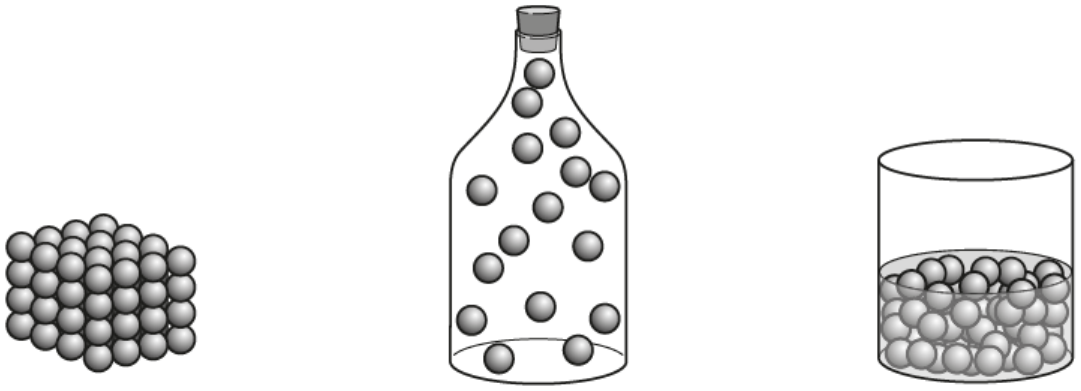
Tick (✓) **two** boxes.

Condensation	☐
Chemical change	☐
Evaporation	☐
Physical change	☐
Melting	☐
Combustion	☐

[2]

(b) **Fig. 2.1** represents the three states of matter: **solid**, **liquid** and **gas**.

(i) Write the word for the correct state under each model.



....

[1]

Fig. 2.1

(ii) **Fig. 2.2** shows a molecule of oxygen, O_2.

O=O

Fig. 2.2

Draw a similar diagram to show a molecule of water, H_2O.

[1]

(c) The table shows the percentage of nitrogen and carbon dioxide in air:

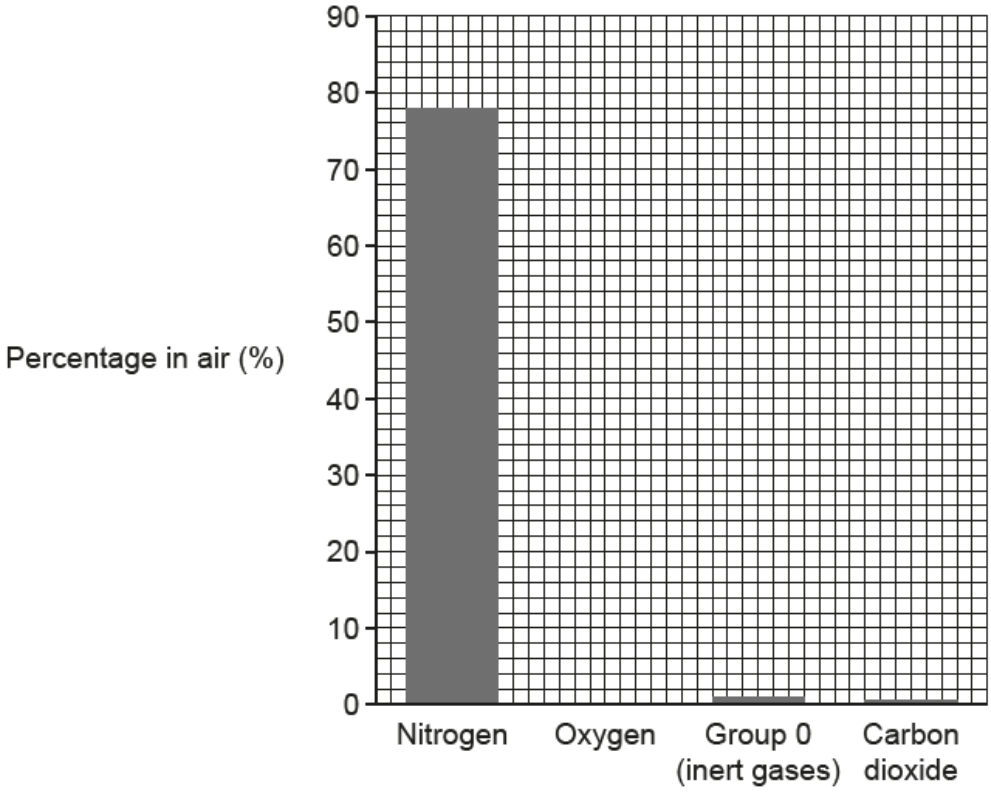
Gas	Percentage (%)
Nitrogen	78
Carbon dioxide	0.04

(i) Calculate how many times more nitrogen there is than carbon dioxide in air.

..... times more nitrogen than carbon dioxide **[2]**

(ii) Oxygen is 21% of air.

Plot the data for oxygen on the bar chart.



[1]

(iii) Draw lines to connect each **gas** with its correct **property**.

Gas	Property
Group 0 (inert gases)	Unreactive.
Carbon dioxide	Relights a glowing splint.
Oxygen	Turns limewater milky.
	Turns litmus blue.

[3]

10. Nov/2021/Paper_J258/03/No.11(c)

(c) Lithium is made by the electrolysis of molten lithium chloride.

Name the product formed at each electrode.

Cathode .....

Anode .....

[2]

11. Nov/2021/Paper_J258/03/No.9

Ammonia is used to make synthetic fertilisers.

Ammonia is made by the Haber process.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

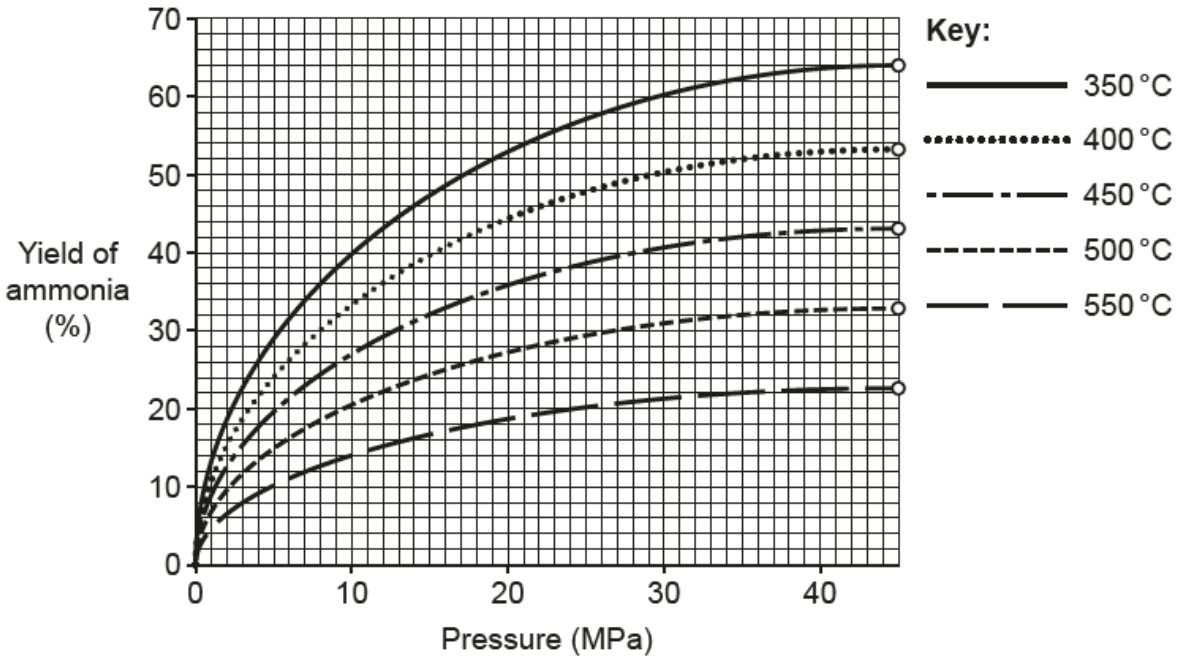
(a) The reaction in the Haber process reaches equilibrium.

Describe the rates of the forward and reverse reactions at equilibrium.

.....

..... **[1]**

(b) The graph shows the effect of temperature and pressure on the yield of ammonia in the Haber process:



(i) State the **lowest** temperature and pressure necessary to get a yield of ammonia of 15%.

Temperature = ...°C

Pressure = ... MPa

[1]

(ii) Suggest **one** disadvantage of using a temperature of 350 °C rather than 450 °C in the Haber process.

.....

..... **[1]**

12. Nov/2020/Paper_J258/03/No.2

Beth has some tablets that react by fizzing, and then dissolving, when water is added.

Beth puts a whole tablet into **Tube A**, and a broken-up tablet into **Tube B**.

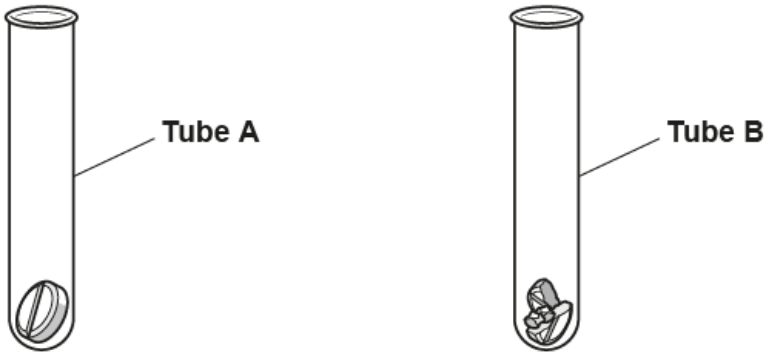


Fig. 2.1

(a) Beth wants to measure the rate of the two reactions. This is Beth's method:

- Add the same volume of **cold** water to each test tube at the same time.
- Start a stopwatch.

(i) When should Beth stop the stopwatch?

Tick (✓) **one** box.

When the bubbles start to appear. ☐

When the fizzing starts. ☐

When the fizzing stops. ☐

When only a small amount of tablet is left. ☐

[1]

(ii) Which type of tablet, whole or broken-up, will dissolve more quickly?

Whole tablet ☐

Broken-up tablet ☐

Explain your answer.

Use ideas from the particle model in your answer.

.....

.....

..... **[2]**

(b) Suggest **one** reason why the reactions are much faster using **hot** water.

.....

..... **[1]**

(c) **Fig. 2.2** shows how the mass of **Tube A** and its contents changes over time when cold water is added.

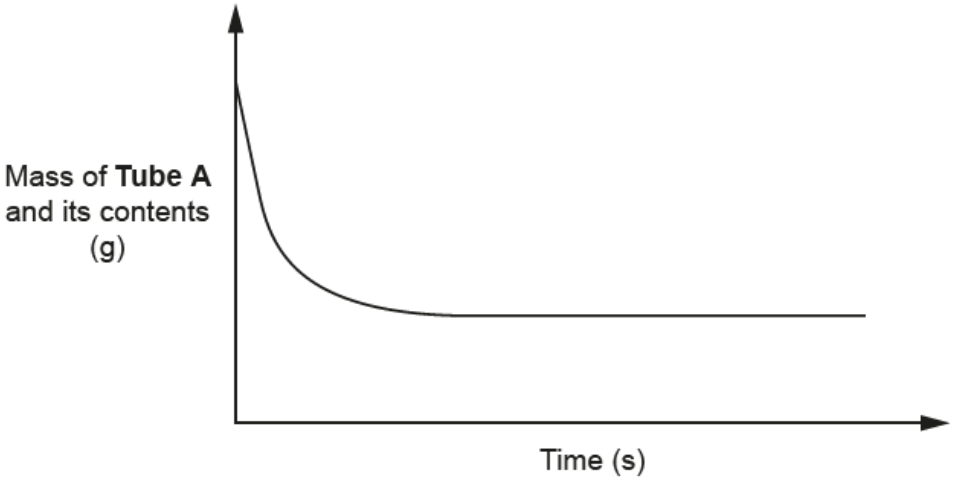


Fig. 2.2

(i) Using **Fig. 2.2**, explain why the mass of **Tube A** and its contents decreases during the reaction.

.....

..... **[1]**

(ii) The rate of the reaction decreases with time.

Describe how **Fig. 2.2** shows this.

.....

..... **[1]**

(iii) Explain why the rate of reaction decreases with time.

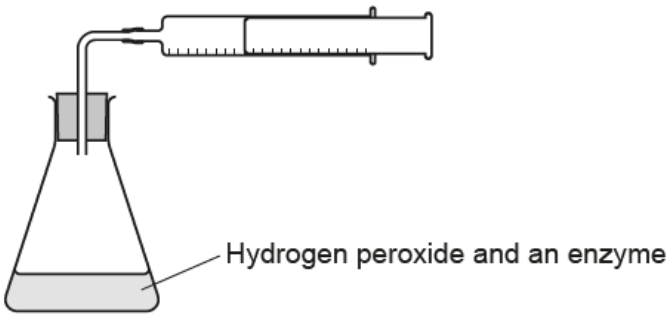
.....

..... **[1]**

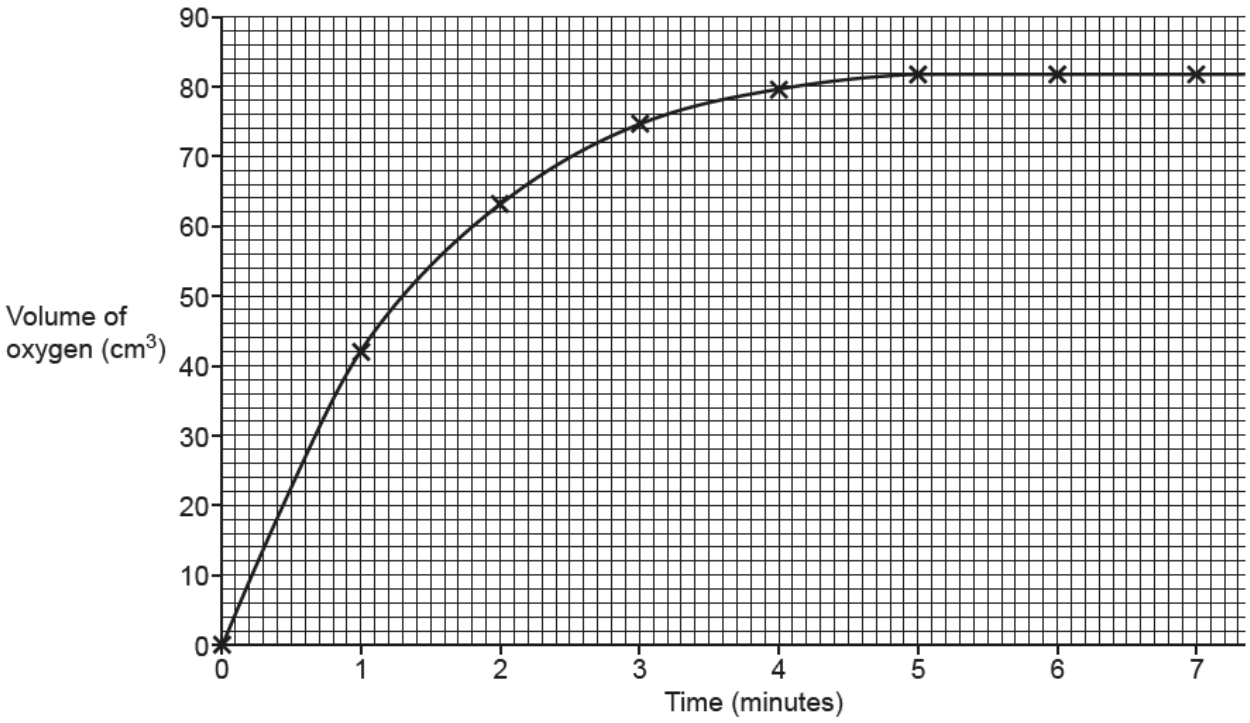
13. Nov/2021/Paper_J258/04/No.2

Hydrogen peroxide is a waste product produced by cells in our bodies. Hydrogen peroxide is broken down by an enzyme to form water and oxygen.

Beth adds a small amount of an enzyme to some hydrogen peroxide. She collects the oxygen given off in a gas syringe. She records the total volume of oxygen every minute.



The graph shows her results.



(a) Use the graph to help you answer **(a)**.

(i) How long does it take for the reaction to finish?

..... minutes **[1]**

(ii) How much oxygen is given off by the end of the reaction?

..... cm^3 **[1]**

(iii) Calculate the average volume of oxygen given off **per second**.

..... cm^3/s **[2]**

(b) The reaction that breaks down hydrogen peroxide does not start until the enzyme is added. When the enzyme is added, oxygen is given off quickly.

Explain this statement.

Use ideas about rates of reaction in your answer.

.....

.....

.....

..... **[2]**

14. Nov/2021/Paper_J258/03/No.9

The table shows the hydrogen ion concentration and the pH for different concentrations of **two** dilute acids.

(a) Complete the information in the table.

Name of acid	Concentration of acid (mol/dm^3)	Concentration of hydrogen ions in solution (mol/dm^3)	pH
Hydrochloric acid	0.50	5.0×10^{-1}	0.3
	0.10	1.0×10^{-1}	1.0
	0.02	2.0×10^{-2}	1.7
	.....	1.0×10^{-2}	2.0
	0.001	1.0×10^{-3}	.....
Sulfuric acid	0.30	6.0×10^{-1}	0.2
	0.10	.....	0.7
	0.01	2.0×10^{-2}	1.7

[2]

(b) Which acid in the table shows the **highest** concentration of hydrogen ions in solution?

Tick (✓) **one** box.

$0.50\ mol/dm^3$ hydrochloric acid ☐

$0.10\ mol/dm^3$ hydrochloric acid ☐

$0.30\ mol/dm^3$ sulfuric acid ☐

$0.10\ mol/dm^3$ sulfuric acid ☐

[1]

(c) Sundip writes this relationship:

pH α concentration of hydrogen ions

(i) What does Sundip's relationship mean?

.....

..... **[1]**

(ii) Do you agree with Sundip's relationship?

Yes ☐

No ☐

Use data from the table to support your answer.

.....

.....

.....

..... **[2]**

(d) **(i)** Complete the **symbol** equations to show what happens when hydrochloric acid and sulfuric acid each form ions.

hydrochloric acid	→	hydrogen ions	+	chloride ions
HCl	→	H^+	+	.....
sulfuric acid	→	hydrogen ions	+	sulfate ions
H_2SO_4	→	$2H^+$	+	.....

[2]

(ii) Explain why the same concentration of hydrochloric acid and sulfuric acid have different concentrations of hydrogen ions and different pH values.

.....

.....

.....

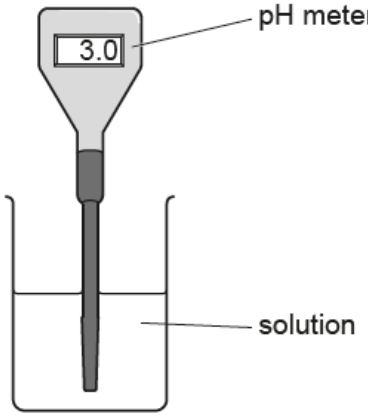
..... **[2]**

15. Nov/2020/Paper_J258/04/No.8

Nina tests three different pH meters to find out which pH meter gives the most accurate pH readings.

She prepares six solutions, **A**, **B**, **C**, **D**, **E** and **F**. Each solution has a different concentration of hydrogen ions, H^+.

She dips the pH meters into each solution and takes a reading.



The table shows her results.

Solution	Concentration of H^+ ions (mol/dm^3)	actual pH	Reading from pH meter 1	Reading from pH meter 2	Reading from pH meter 3
A	1.0×10^{-3}	3.0	2.9	3.3	2.6
B	1.0×10^{-5}	5.0	4.9	5.4	4.4
C	1.0×10^{-2}	2.0	2.1	2.2	2.7
D	1.0×10^{-1}	1.0	0.9	1.3	1.5
E	1.0×10^{-9}	9.0	9.1	9.2	8.4
F	1.0×10^{-7}	7.0	7.1	7.3	7.5

(a) Identify one neutral solution and one alkali solution from the table.

Neutral solution: .....

Alkali solution: .....

[1]

(b) Predict the actual pH of a solution with a concentration of 1.0×10^{-4} mol/dm^3 of hydrogen ions.

pH = ... **[1]**

(c) What is the trend in the relationship between concentration of hydrogen ions and pH?

.....

..... **[1]**

(d) What conclusions can you make about the relative accuracy of each pH meter?

Explain each conclusion.

pH meter 1: .....

.....

pH meter 2: .....

.....

pH meter 3: .....

.....

[3]

(e) Nina thinks that she has contaminated her solutions during the experiment.

What should Nina do to make sure that her solutions do not become contaminated during the experiment?

.....

..... **[1]**